

## CLAIMS

[1] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes, which is characterized by monitoring of displacements of a bore - hole wall during application of cyclic loading imposed on the bore - hole wall at a given testing soil layer.

[2] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 1, which is characterized by applying the cyclic loading alternatively to the multiple zones located along the bore - hole axis, and hence applying the cyclically alternating shear loading at the central soil layer located between the two adjacent loaded zones.

[3] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 2, which is aimed at deriving the strength by applying the static loading to the central soil layer after cyclic loading imposed on the same soil layer .

[4] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils using bore - hole according to claim 1, which is aimed at inferring the dynamic characteristics of soils from the relations among the amplitudes of cyclic loading, number of cycles and displacements, during the conduct of application of the cyclic loading imposed alternatively on a single zone located along the bore - hole axis, and hence applying the cyclically alternating shear loading at the central soil layer located between the two adjacent loaded zones.

[5] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils

using bore - holes according to claim 1 or 4, which is characterized by the conduct of cyclic loading using one or some combinations of three loading types, i. e. compressional loading imposed orthogonal to the bore - hole axis, torsional loading imposed around the bore - hole axis, and shear loading imposed parallel to the bore - hole axis.

[6] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes, which is equipped with the monitoring zonde that is lowered down into the bore - hole and applies the pressure to the bore - hole wall via a pressure-transmitting medium, the pressure controlling unit that can change the pressure carried by the medium in the monitoring cell periodically, and the monitoring unit for the displacement of the bore - hole wall.

[7] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 6, in which the monitoring zonde is composed of multiple cells located along the bore - hole axis that can apply the pressure to the bore - hole wall, and the pressure controlling unit can apply the cyclic pressure alternatively to these multiple cells.

[8] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 7, in which the pressure controlling unit can apply the cyclic pressures alternatively to the top and bottom cells and can apply the static pressure to the central cell.

[9] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 6, which is equipped with the torque generating unit that can apply the cyclic loading around the bore - hole axis with the monitoring cell intimately attached to the bore - hole wall, and the monitoring unit for the rotational displacements generated by the torsional cyclic

loading.

[10] In - situ testing method for the evaluation of liquefaction and dynamic characteristics of soils using bore-holes according to claim 6 or 9, which is equipped with the shear load - generating unit that can apply the cyclic loading parallel to the bore - hole axis with the monitoring cell intimately attached to the bore - hole wall, and the monitoring unit for the shear(axial) displacements generated by the cyclic shear loading.

[11] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes having a monitoring zonde lowered down into the bore - hole, the monitoring zoned is composed of multiple cells that have independent pressure rooms, and each independent cell is designed to apply the loading to the corresponding soil layer by controlling the pressure carried by the liquid medium in the pressure room and a central cell of the multiple cells can apply the static loading, and top and bottom cells that can apply the cyclic loading to the corresponding soil layers, the top and bottom guard cells are provided on top of all the cells and beneath all of the cells, respectively.

[12] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 11, which is equipped with a pore water pressure gauge located at the central cell of the monitoring cell.

[13] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 12, which is equipped with the pore water pressure gauge that possesses a sensor unit on the surface of the inflatable membrane of the central cell.

[14] In - situ testing apparatus for the evaluation of liquefaction and dynamic

characteristics of soils using bore - holes, in which the monitoring zoned lowered down into the bore - hole is composed of multiple cells that have independent pressure rooms, and each independent cell is designed to apply the loading to the corresponding soil layer by controlling the pressure carried by the liquid medium in the pressure room, and each cell is independent and the connections of the cells are exchangeable.

[15] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 14, wherein each cell is composed of a cell body itself, cylindrical membrane attached to the circumference of the cell body and the pressure room filled with a liquid medium located between the cell body and the membrane.

[16] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 15, wherein seal plates are inserted in between the cells, so that the membranes of the adjacent cells can be intimately connected with each other.

[17] In - situ testing apparatus for the evaluation of liquefaction and dynamic characteristics of soils using bore - holes according to claim 11 or 14, which is equipped with the following units, i. e. a cylinder that generates the pressure carried by the liquid medium in the pressure room, the monitoring unit measuring the movement of the cylinder rod, and the unit deriving the displacement of the bore - hole wall from the measurement of the movement of the cylinder rod.